CONTRIBUTION TO T1 STANDARDS PROJECT — T1X1.5

TITLE: Proposed OCh-OH Assignments for the OCh Frame

AUTHOR: James Ballintine (ballintine@lucent.com, +1 732 949 6340)

SOURCE:

Lucent Technologies
Bell Labs Innovations

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CONTACT: S. J. (John) Chen
Lucent Technologies
Room 4L-322
101 Crawfords Corner Road
Holmdel, NJ 07733 USA

Tel: +1 732 949 5179
Fax: +1 732 949 5055
E-mail: sjchen@lucent.com

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ABSTRACT:

The Lucent contribution, *A Proposed Implementation for a Digital "Wrapper" for OCh Overhead*, proposes a specific frame structure for the Optical Channel based on the existing ITU-T Recommendation G.975, *Forward Error Correction for Submarine Systems*. This contribution proposes specific OCh-OH assignments for the OCh frame, based on the requirements for OCh layer OAM as described in ITU-T Rec. G.872, *Architecture of Optical Transport Networks*.

This contribution was presented as a Lucent contribution to April 1999 Q.11/15 Experts Meeting in Munich. Lucent is proposing that this contribution be submitted as a Lucent contribution to the June meeting of ITU-T Study Group 15.

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The Lucent contribution, *A Proposed Implementation for a Digital "Wrapper" for OCh Overhead*, proposes a specific frame structure for the Optical Channel based on the existing ITU-T Recommendation G.975, *Forward Error Correction for Submarine Systems* [2]. This contribution proposes specific OCh-OH assignments for the OCh frame, based on the requirements for OCh layer OAM as described in ITU-T Rec. G.872, *Architecture of Optical Transport Networks* [1].

1 Introduction

As described in a companion contribution [4], the format specified in G.975 can be used as the TDM frame for Optical Channels (e.g. carrying STM-16 or STM-64 rate client signals). That contribution provided a detailed description of the proposed basic OCh frame format, with proposed allocation of the available overhead for a sub-set of functions including framing, performance verification via parity checking, and un-allocated or "miscellaneous" OCh-OH. This contribution proposes allocation of the remaining un-allocated or "miscellaneous" bandwidth (32 bytes of the proposed OCh frame) to support OCh-level OAM functions as described in ITU-T Rec. G.872.

2 Framework

The OCh-level OAM functionality described in ITU-T Rec. G.872 (see Table 1/G.872) comprises the following:

- **Trail Trace (OCh-ID):** Provides the capability to verify connectivity through connection functions (e.g. patch panels, Optical ADM, Optical Cross Connect).

* Contact Person: J. E. Ballintine
101 Crawfords Corner Road
Holmdel, NJ 07733 USA

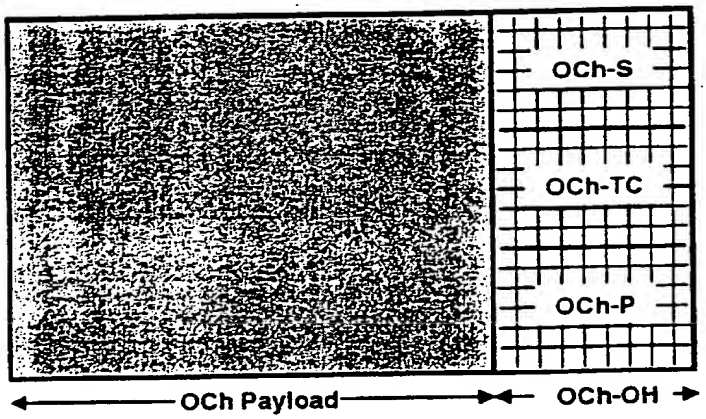
Tel: +1 732 949 0634
Fax: +1 732 949 1575
Email: ballintine@lucent.com

- **Signal Label (OCh-SL):** Provides the capability to verify that the client signal is compatible with the equipment to which it is connected
- **Signaling for per channel protection mechanisms (OCh-APS):** for example OCh Shared Protection Rings (OCh/SPRINGs)
- **Forward & Backward Defect Indication (OCh-FDI/BDI):** Provides the capability to localize faults and enables single ended maintenance
- **Signal Quality Monitoring & Backward Quality Indication (OCh-SQM/BQI):** Provides the capability to isolate sources of degraded performance and verify quality of service
- **Tandem Connection Maintenance (OCh-TCM):** Provides the capability to maintain a channel through an entire subnetwork that does not include the OCh termination elements

Note that while Table 1/G.872 identifies subnetwork/tandem/unused connection supervision as FFS (for further study) for the OCh layer network, bandwidth is allocated for OCh-TCM in support of the US contribution to SG 13, *Need for Sublayer Management in the OTN* [6], and the Hermes contribution to SG13, *Tandem Connection Management Applications in the OCh Network Layer* [7].

2.1 Layered OCh Overhead

For Optical Layer maintenance purposes the OCh is "sublayered" into the OCh Section, OCh Tandem Connection, and OCh Path sublayers as illustrated in Figure 1.



- **OCh-S (Section)**
  - Framing
  - FEC
  - PM
  - Data Communication
- **OCh-TC (Tandem Connection)**
  - TCM (ID, FDI/BDI,SDM/BQI)
  - OCh-APS
  - Data Communication
- **OCh-P (Path)**
  - OCh-ID, OCh-SL
  - OCh-APS
  - OCh-FDI/BDI
  - OCh-SQM/BQI
  - Data Communication

Figure 1: Basic OCh Frame Structure

A network element that processes overhead and performs maintenance at a particular sublayer must also perform the overhead processing and maintenance at the lower sublayers. Since the OCh-OH is included in the FEC calculation, any network element that writes OCh-OH must also recalculate the FEC information (when FEC is active).

- An OCh Section terminating network element processes the OCh Section Overhead (OCh-SOH) and performs the associated functions while passing the OCh Tandem Connection Overhead (OCh-TCOH) and the OCh Path Overhead (OCh-POH) unaltered. This sublayer of the OCh is required to allow maintenance of the link between 3R regeneration points.
- An OCh Tandem Connection terminating network element processes the OCh-SOH and OCh-TCOH while passing the OCh-POH unaltered. This sublayer is required to support Tandem Connection maintenance functions that were agreed in the February 1999 Q19/13 meeting.

- An OCh Path terminating network element processes the OCh-SOH, OCh-TCOH, and the OCh-POH. This sublayer provides the functions required for OCh maintenance as described in Recommendation G.872 [1].

The basic structure of the OCh-OH that describes the allocation of bytes for FEC and the remainder of the OCh-OH is given in a companion contribution *A Proposed Implementation for a Digital "Wrapper" for OCh Overhead* [4]. The following sections describe the proposed byte allocations of each of the OCh-OH functions within the OCh frame, which is illustrated in Figure 2.

	OCh-SOH	OCh-SOH/ OCh-TCOH	OCh-POH	
Subframe#	Frame 1	Frame 2	Frame 3	Frame 4
1	OA1 Framing	OJ1 OCh Section Trace	OJ3 OCh Path Trace	OB1_1 OCh Path BIP-8
2	OA1 Framing	OD1 OCh Section Data Com.	OC1 OCh Signal Label	OB1_2 OCh Path BIP-8
3	OA1 Framing	X2_3 OCh Section Growth	OG2 OCh Path Status	OB1_3 OCh Path BIP-8
4	OA1 Framing	X2_4 OCh Section Growth	OM2 OCh Path BQI	OB1_4 OCh Path BIP-8
5	OA1 Framing	X2_5 OCh Section Growth	OK4 OCh Path APS	OB1_5 OCh Path BIP-8
6	OA1 Framing	OJ2 OCh TC Trace	OK5 OCh Path APS	OB1_6 OCh Path BIP-8
7	OA1 Framing	OG1 OCh TC Status	OK6 OCh Path APS	OB1_7 OCh Path BIP-8
8	OA1 Framing	OM1 OCh TC BQI	OD3 OCh Path Data Com.	OB1_8 OCh Path BIP-8
9	OA2 Framing	ON1 OCh TC IEC	X3_9 OCh Path Growth	OB1_9 OCh Path BIP-8
10	OA2 Framing	OK1 OCh TC APS	X3_10 OCh Path Growth	OB1_10 OCh Path BIP-8
11	OA2 Framing	OK2 OCh TC APS	X3_11 OCh Path Growth	OB1_11 OCh Path BIP-8
12	OA2 Framing	OK3 OCh TC APS	X3_12 OCh Path Growth	OB1_12 OCh Path BIP-8
13	OA2 Framing	OD2 OCh TC Data Com.	X3_13 OCh Path Growth	OB1_13 OCh Path BIP-8
14	OA2 Framing	X2_14 OCh TC Growth	X3_14 OCh Path Growth	OB1_14 OCh Path BIP-8
15	OA2 Framing	X2_15 OCh TC Growth	X3_15 OCh Path Growth	OB1_15 OCh Path BIP-8
16	OA2 Framing	X2_16 OCh TC Growth	X3_16 OCh Path Growth	OB1_16 OCh Path BIP-8

Note: All defined bytes have a leading 'O' which stands for OCh. All undefined (growth) bytes have the format X"OH column number"_"OH row number" (e.g., X3_16, OCh Path Growth)

Figure 2: OCh Frame Overhead Byte Allocations

3 OCh Overhead Definitions and Functions

The assignment of bytes within the OCh-OH frame is shown in Figure 2. The meaning of each of these bytes is described in this section.

3.1 OCh-SOH (Optical Channel Section Overhead)

The sections below describe the OCh-OH byte allocations for the OCh-S layer.

3.1.1 Framing (OA1, OA2)

Sixteen bytes are allocated in each OCh frame for framing. The first eight, labelled OA1, have the value F6 Hex. The next eight, labelled OA2, have the value 28 Hex.

3.1.2 Section Trace (OJ1)

The OCh section trace is a sixteen byte message that repeats every 16 OCh superframes. The formatting is as defined for the J0 byte in ITU-T Recommendation G.707, *Network Node Interface for the Synchronous Digital Hierarchy (SDH)* [3]. It is intended to verify connectivity between section terminating network elements.

3.1.3 Section Data Communications (OD1)

The OCh section data communication channel is used for message based communication betwee section terminating network elements.

3.1.4 Section Growth (X2_3-X2_5)

The OCh section growth bytes are reserved for future section maintenance functions.

3.2 OCh-TCOH (Optical Channel Tandem Connection Overhead)

The sections below describe the OCh-OH byte allocations for the OCh-TC layer.

3.2.1 OCh Tandem Connection Trace (OJ2)

The OCh tandem connection trace is a sixteen byte message that repeats every 16 OCh superframes. The formatting is as defined for the J0 byte in ITU-T Recommendation G.707, *Network Node Interface for the Synchronous Digital Hierarchy (SDH)* [3]. It is intended to verify connectivity between OCh tandem connection terminating network elements.

3.2.2 OCh Tandem Connection Status (OG1)

Bits 5-8 of OG1 shall be used to convey OCh-TC-FDI and OCh-TC-BDI. Sixteen codes are available to allow various severity indications.

Bits 1-4 of OG1 are used to indicate whether the Tandem Connection is equipped. The value 0000 indicates unequipped. Any other value shall be considered equipped.

3.2.3 OCh Tandem Connection Backward Error Indication (OM1)

The OCh Tandem Connection Backward Error Indication byte (OM1) contains the number of tandem connection errors observed in the reverse direction tandem connection during the previous OCh frame. The number of OCh tandem connection errors is equal to the absolute value of the difference between the incoming OCh Tandem Connection Incoming Error Count and the observed OB1 parity error count. The value is calculated and inserted every OCh frame.

3.2.4 OCh Tandem Connection Incoming Error Count (ON1)

The OCh Tandem Connection Incoming Error Count byte (ON1) contains the number of parity errors detected in the previous incoming OCh frame at the tandem connection source.

3.2.5 OCh Tandem Connection Automatic Protection Switching (OK1-OK3)

These bytes are reserved for communicating protection switching protocol messages at the OCh-TC layer.

3.2.6 OCh Tandem Connection Data Communications (OD2)

The OCh tandem connection data communication channel is used for message based communication between OCh tandem connection terminating network elements.

3.2.7 OCh Tandem Connection Growth (X2_14 - X2_16)

The OCh tandem connection growth bytes are reserved for future OCh tandem connection maintenance functions.

3.3 OCH-POH (Optical Channel Path Overhead)

The sections below describe the OCh-OH byte allocations for the OCh-P layer.

3.3.1 OCh Path Trace (OJ3)

The OCh path trace is a sixteen byte message that repeats every 16 OCh superframes. The formatting is as defined for the J0 byte in ITU-T Recommendation G.707, *Network Node Interface for the Synchronous Digital Hierarchy (SDH)* [3]. It is intended to verify connectivity between OCh path terminating network elements.

3.3.2 OCh Signal Label (OC1)

The OC1 Signal Label byte shall be used to indicate the type of the payload transported in the OCh path envelope. This provides up to 256 codes to ensure that payloads are compatible with the adaptation functions in the OCh termination.

3.3.3 OCh Path Status (OG2)

Bits 5-8 of OG2 shall be used to convey OCH-P-FDI and OCH-P-BDI. Sixteen codes are available to allow various severity indications.

Bits 1-4 of OG2 are currently undefined and should normally be set to zero.

3.3.4 OCh Path Backward Error Indication (OM2)

The OCh Path Backward Error Indication byte (OM2) contains the number of errors observed at the path termination of the reverse direction. It is transmitted every OCh frame.

3.3.5 OCh Path Automatic Protection Switching (OK4-OK6)

These bytes are reserved for communicating protection switching protocol at the OCH-P layer.

3.3.6 OCh Path Data Communication (OD3)

The OCh path data communication channel is used for message based communication between OCh path terminating network elements.

3.3.7 OCh Path User (OF3)

One byte is provided for user functions at the OCh path layer.

3.3.8 OCh Path BIP-8 (OB1_1-OB1_16)

Each OB1_n byte contains the BIP-8 (Bit interleaved parity) for subframe n of the previous OCh frame. The parity is calculated over the all of the payload (columns 2-239) and the OCh-POH (column 1, frames 3 and 4). Since the number of bytes in a parity block is even, Odd parity shall be used so that AIS signals can be defined using all ones patterns.

3.3.9 OCh Path Growth (X3_9-X3_16)

The OCh path growth bytes are reserved for future path maintenance functions.

4 Proposal

Lucent proposes that the format specified in G.975 with the OCh-OH definitions provided in this contribution be adopted as the TDM frame for Optical Channels (e.g. carrying STM-16 or STM-64 rate client signals).

This proposal is offered as the basis for developing the OCh-level aspects of the OTN-NNI in draft Rec. G.709 [5].

5 References

1. ITU-T COM 13-49-E, *Draft Recommendation G.872 - Architecture of Optical Transport Networks*, (October 1998).

2. ITU-T Recommendation G.975, *Forward Error Correction for Submarine Systems*, (November 1996)

3. ITU-T Recommendation G.707, *Network Node Interface for the Synchronous Digital Hierarchy (SDH)*, (June 1996).

4. WD-02 Q11/15 Rapporteur's Meeting, April 1999, *A Proposed Implementation for a Digital "Wrapper" for OCh Overhead*, Lucent Technologies.

5. ITU-T TD-50 (WP 3/15), *Report of Q.11/15 (Part I - Annexes), Annex BB: Draft New Rec. G.709 (ex G.ons) - Network Node Interface for the Optical Transport Network*, (October 1998).

6. ITU-T COM 13-854, *Need for Sublayer Management in the OTN*, United States of America (February 1999).

7. ITU-T COM13-D841, *Tandem Connection Management Applications in the OCh Network Layer*, Hermes Europe Railtel (February 1999).